Helicopter money: what is it and what does it do?*

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Abstract

We review the different meanings of helicopter money both in the literature and in the public debate around it, and clarify the conditions under which helicopter money can have an impact on real activity. To do so, we set out a simple model that encapsulates a number of potential channels of policy transmission. The model provides a taxonomy of possibilities for helicopter money to affect the economy, as well as a benchmark set of conditions under which it is neutral. We use the model to analyse and discuss the impact that helicopter drops might have in response to a number of economic shocks, including a financial crisis, a fiscal crisis, and a pandemic.

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1 Introduction

Following the aftermath of the financial and euro-area crises, several academics, practitioners and commentators have revived the idea of "helicopter money" as a potential tool to offset disinflationary slowdowns when other fiscal or monetary policy tools are not available. The debate intensified at the onset of the COVID-19 pandemic, when many feared that there might not be enough conventional policy headroom to respond to the unprecedented crisis.

The lively debates led to different interpretations of helicopter drops, which in turn led to policy proposals from different sectors, ranging from Blackrock's Report (Bartsch, Boivin, Fischer, Hildebrand, and Wan (2019)) to People's Quantitative Easing, as proposed by Jeremy Corbyn during the campaign to lead the Labor Party in 2015.[1] The discussion involved comparisons between helicopter drops and either monetary policy through quantitative easing (as carried out by central banks) or standard fiscal policy implemented through debt-financed increases in government spending or tax cuts.[2]

What exactly is "helicopter money"? When and how does it work? Under what conditions can it stimulate the economy? What economic shocks could it help offset? This paper surveys the literature and studies helicopter money within a conventional macroeconomic framework to answer these questions.

We lay out the conditions that render the policy non-neutral, that is, capable of affecting the real economy. The analysis is strictly positive and does not engage with the normative question of whether helicopter money drops should be deployed, or indeed whether it is feasible to implement such a policy without putting at risk central bank independence and the clear governance and accountability that stems from a sharp separation of monetary and fiscal functions. (Under most definitions, helicopter money is a hybrid policy that requires the intervention and coordination of fiscal and monetary policy authorities and, as such, it may not be consistent with the institutional setups in many jurisdictions.) Instead, the paper focuses on the economic channels through which helicopter money may transmit to the real economy.

To carry out the analysis, the paper starts by setting out a simple model that encapsulates a number of potential channels of transmission. It then establishes the conditions

[1] A defense is here: https://www.taxresearch.org.uk/Blog/2020/07/21/quantitative-easing-a-video-explanation/

[2] FT, Chris Giles, "People's Quantitative Easing – No Magic" (13 August, 2015); Blanchard and Pisani-Ferry (2019).

that sustain (or break) the neutrality of helicopter money, that is, its ability to affect the real economy. The model helps us organise a taxonomy of possibilities stemming from deviations from those neutrality conditions. As the model makes transparent, a number of implementation questions become critical in determining the impact of a helicopter policy: is the helicopter drop implemented as an increase in (non-interest-bearing) currency (cash or banknotes) or as an increase in interest-bearing deposits at the central banks? Was the demand for what is dropped by the helicopter already satiated or not? Is the central bank fully fiscally backed by the government? Is the drop permanent or temporary? Does the central bank have (other) tools to achieve its inflation target? Does the helicopter money drop redistribute wealth across agents?

After addressing those questions, we use the model to analyse and discuss the impact that helicopter drops might have in response to a number of economic shocks. These include (stylised versions of) a financial crisis, a fiscal crisis, and a pandemic, as well as different circumstances such as whether the economy is near the zero lower bound or whether there is a central bank digital currency.

The rest of the paper is organised as follows. Section 2 reviews the definition of helicopter money, going back to Friedman (1969)'s introduction. Section 3 sets out the model and discusses the various channels of policy transmission. Section 4 establishes the conditions for the neutrality of helicopter drops and studies a number of deviations from those neutrality conditions. Section 5 discusses the impact of helicopter drops in response to several economic shocks. Finally, section 6 concludes.

2 The different meanings of helicopter money

The concept of helicopter drops was first introduced in an influential paper by Friedman (1969), who invited his readers to carry out the following thought experiment: "*Let us suppose now that one day a helicopter flies over this community and drops an additional $1,000 in bills from the sky, which is, of course, hastily collected by members of the community. Let us suppose further that everyone is convinced that this is a unique event which will never be repeated.*" Critically for Friedman's experiment not to be a standard tax- or debt-financed fiscal expansion, the helicopter drop would be financed by a one-off increase in the nominal quantity of money issued by the central bank.[3] Therefore, his experiment envisages

[3]Friedman also considered a fiscal expansion financed by an increase in the *rate of money growth*, as in previous contributions by Sidrauski (1967a) and Sidrauski (1967b).

an increase in banknotes and a fall in the net worth of the central bank (and an increase in the net worth of the private sector).

The earlier monetary literature, which built on Friedman (1969) and Sidrauski (1967a), often modelled monetary policy as helicopter drops inevitably associated to a fiscal expansion. In the past few decades, however, modelling approaches to monetary policy have drawn a clear distinction between fiscal and monetary policy, consistent with the institutional separation of the two policies in practice in many countries (e.g. Woodford (2003) and Galí (2015)). In those settings, monetary policy interventions are introduced as changes in short (or long) term rates, without any direct fiscal transfer to the private sector, and no change in the balance sheet of the central bank. Helicopter money was therefore gradually removed from standard analysis of conventional monetary policy.

More recently, as many advanced economies reached (or were close to) their effective lower bounds—and were accordingly more limited in their monetary policy headroom—a spate of new papers have revived the idea of helicopter drops as a potential way to create policy space. The discussion gained new impetus at the onset of the COVID 19 crisis, which triggered a call for significant policy stimulus.

The clarity of Friedman's thought experiment, however, got blurred in some of the recent debate. Different academics and practitioners have used the same term, "helicopter money," to describe different policy interventions. For example, Benigno and Nisticò (2020) define helicopter money as a short-run tax cut financed by an increase in the nominal liabilities of either the central bank or the Treasury. In a similar vein, Carter and Mendes (2020) define helicopter drops as fiscal transfers financed by either non-interest rate bearing money (banknotes), as in Friedman's thought experiment, or, alternatively, by interest-rate bearing money (reserves), highlighting the distinction between the two. More narrowly, Ryan-Collins and Van Lerven (2018) use the term helicopter debt as the monetisation of government debt through an explicit monetary-fiscal coordination, with the goal of boosting demand and inflation. In the balance sheet, this would come with an increase in money to buy government bonds. Likewise, Cukierman (2020) defines helicopter money as "a fiscal expansion financed by loans from the central bank that, somewhat less colorfully, is known as seignorage," while Goodhart, Masciandaro, and Ugolini (2021) equate helicopter money to debt monetization. Several papers use a narrower definition. For example, Ball (2008), Borio, Disyatat, and Zabai (2016), Borio and Zabai (2016), Buiter (2003), Buiter (2014), Galí (2020a), Harrison and Thomas (2019), **?**, and English, Erceg, and Lopez-Salido (2017) define helicopter money as a fiscal transfer financed by fiat money that is either permanent or never completely reversed in present discounted value, so the present value of the net worth of the central bank is lower.[4]

Mirroring some of the academic developments, a number of policy proposals, including Bernanke (2016), Ball, Gagnon, Honohan, and Krogstrup (2016), Bartsch et al. (2019), Galí (2020b), Reichlin, Turner, and Woodford (2019), Turner (2015), and Yashiv (2020) define helicopter money as a fiscal policy expansion via direct transfers to the hands of public and/or private sector spenders, financed by new issuance of either currency or reserves.[5] Sinn (2017) uses a similar definition as the basis of his policy criticism to these helicopter-drop proposals. Similarly, in his criticism of helicopter money, Dowd (2018) defines it as the issuance of additional base money to a beneficiary chosen by the central bank (as opposed to being chosen by the fiscal authority as in some of the proposals aforementioned), without receiving any valuable asset in return, so leading to a fall in its net worth.

As the previous summary makes clear, there is a range of definitions in both the academic literature and in the policy debate. For the sake of clarity, in this paper we define helicopter money broadly as a policy intervention that satisfies two properties:

1. It must come with an increase in the liabilities of the central bank (the monetary base).

2. It must directly (holding prices and returns fixed) increase the after-tax nominal income of some private agents.

The first requisite distinguishes the helicopter drop from tax- or debt-financed fiscal transfers. These do not require a monetary policy action, and are best described as standard fiscal policy. The second requisite distinguishes it from conventional monetary policies or from quantitative easing. Both of them only indirectly affect incomes through their effects on short or long interest rates. Quantitative easing, in particular, increases the size of the central bank's balance sheet by raising both its liabilities and assets, but it does not involve any direct transfer to private agents.

[4]Many of these papers study the difference between helicopter drops and debt-financed fiscal expansions. Some argue in favour of helicopter drops, e.g., Ball (2008), while others, including Harrison and Thomas (2019), argue that bond-finance tax cuts can achieve similar effects.

[5]Bartsch et al. (2019) in particular stress the role of direct transfers as the key channel of transmission, bypassing the interest rate channel when the central bank toolkit is exhausted. Many of these papers propose a similar structure, whereby the central bank decides the size of the stimulus, based potentially on the aggregate demand shortfall, leaving the decision on how to distribute it to the fiscal authority. Finally, they argue for helicopter drops in settings in which monetary policy is constrained, as when the policy rate is at the lower bound.

Figure 1: Stylised balance sheet of a central bank

Assets	Liabilities
Public bonds (b^c) and loans to government	Currency (h)
Credit to financial institutions	Interest-paying deposits by banks, bank reserves (v)
Other assets (foreign reserves)	Net worth (e)

Before we proceed to the description of the model and its various concepts, it should be helpful to keep in mind a (stylised) balance sheet of a central bank, as depicted in figure 1. In many advanced economies the majority of its assets are bonds issued by the government, while in emerging economies, direct loans to public entities are more common. Depending on how monetary policy is conducted, central banks lend to banks either only in a crisis, or routinely through repurchase operations. Finally, in open economies, central banks may hold large amount of foreign currency and bonds, as reserves against foreign shocks. On the liabilities side, central banks issue currency—banknotes that pay no interest and anyone can hold—and reserves—deposits by banks that earn an interest. The sum of the two is the monetary base, money for short. The net worth of the central bank is the difference between the assets and these liabilities.

3 A simple model of the transmission channels of monetary policy

The literature has discussed different channels through which helicopter drops might work. To make sense of them, and to compare them with each other, requires having a single coherent model. At a minimum, the model needs to have: (i) a central bank with a non-trivial balance sheet, so that it has something to load the helicopter with, (ii) a fiscal authority that regularly makes transfers and issues liabilities, so there is someone effectively piloting the helicopter, (iii) heterogeneity in the private sector, so that different agents may be the recipients of the drops, and (iv) frictions that break monetary neutrality so that the drops can affect different decisions in the economy. This section presents the simplest model we were able to write to achieve this, and explains how it captures the different transmission mechanisms through which helicopter drops may matter.

3.1 The model

Time is discrete, indexed by t starting from 0, and people have perfect foresight.

3.1.1 Money and the central bank

Public money is both central-bank-issued currency h_t that anyone can hold between $t-1$ and t, and central-bank-issued deposits (reserves) v_t that only banks can hold. Currency pays zero (net) interest, while reserves pay an interest rate chosen by the central bank: i_t^v. The central bank chooses how much money to have outstanding every period, and it can change this by adjusting its holdings of government bonds b_t^c. These simple, one-period, bonds pay an amount δ_t on maturity, and trade at a market-determined price q_t. The budget constraint of the central bank at date t then is:

$$v_{t+1} - v_t + h_{t+1} - h_t + \delta_t b_t^c = q_t b_{t+1}^c + i_t^v v_t + x_t, \tag{1}$$

where x_t are the central bank dividends paid to the fiscal authority or, if negative, a recapitalization received from it. In period 0, the central bank has an exogenous net worth e_0, which is just the difference between the bonds it had coming in, and the reserves and currency previously outstanding.

Because money is denominated in the unit of account, there is a price level p_t, that states the number of units of money that a unit of goods costs. Inflation is $\pi_t = p_t/p_{t-1}$, and we assume there is a target for it, π^*. We take the initial price level as given, abstracting from the long literature on how this is determined (Castillo-Martinez and Reis, 2019).

Conventional monetary policy consists of choices of the interest paid on reserves i_t^v in order to achieve the inflation target. Quantitative easing is an increase in $v_{t+1} + h_{t+1}$ that comes with an increase in bond holdings $q_t b_{t+1}^c$, but no change in the resources of the private sector. Helicopter drops instead come with an increase in $v_{t+1} + h_{t+1}$ and a direct transfer to the fiscal authority x_t that it will distribute to private agents, as we explain next.

3.1.2 The fiscal authority

We assume that the role of carrying the money and distributing it is performed by the fiscal authority. It is hard to see how a modern central bank could do this, unless people had deposits at the central bank. We will discuss this in section 5.6, but until then, it is the fiscal authority that makes transfers to private agents, denoted by s_t.

The total amount of government bonds outstanding is b_t, taking b_0 as given. We assume that bonds are expected to pay in full, so every agent believes that $\delta_t = 1$. The budget constraint of the fiscal authority then is:

$$x_t + q_t b_{t+1} = \delta_t b_t + s_t + p_t g_t, \tag{2}$$

where g_t is real government spending in some publicly-provided goods, that is taken as given by agents.

Choices of fiscal policy correspond to choices of purchases and total transfers (g_t, s_t), as well as the composition of these transfers, which we will discuss soon. Different forms of helicopter drop map into changes in that total and composition following the money received from the central bank.

3.1.3 Households: savers and spenders

We consider two types of households, and a representative agent within each type. The first, and simplest, type are spenders. Their only income is government transfers s_t^h, and they consume it hand-to-mouth right away, so their real consumption is $c_t^h = s_t^h / p_t$ every period. They do not save or hold any assets.

The second type are savers. Their total financial assets are a_t, starting from an initial exogenous a_0, and they have a desire to save because they discount future utility by β. These assets are split between holdings of: government bonds b_t^p, banknotes h_t, and bank deposits d_t. Their income is both labor income, given a wage w_t paid for labor supplied l_t, and capital income k_t that comes from their ownership of firms. To this income, the government adds transfers s_t^p.

In turn, they spend to consume c_t, with the goal of maximizing a period utility function: $\log(c_t) - \alpha l_t$.[6] However, for every unit they consume, they must also pay a transaction cost Ψ_t. This depends on how much currency or deposits they carried from the

[6] The public goods supplied by the government give utility according to some additive increasing concave function. Because this plays no role in the analysis, we leave it unspecified.

previous period, since these ease transactions by lowering their costs. Households can be satiated with liquidity, which happens when the inverse velocity of currency (h_t/p_tc_t) and deposits (d_t/p_tc_t) are equal to a satiation point h^* and d^*. This way, once velocity is low enough, the transaction costs are zero.

Combining all these ingredients, the problem of these households is:

$$\max \quad \sum_t \beta^t(\log(c_t) - \alpha l_t) \quad \text{subject to:} \tag{3}$$

$$p_tc_t(1+\Psi_t) + q_tb^p_{t+1} + h_{t+1} + d_{t+1} = a_t + w_tl_t + k_t + s^p_t \tag{4}$$

$$a_t = \delta_tb^p_t + h_t + d_t(1+i^d_t) \tag{5}$$

$$\Psi_t = \psi_h h^* \max\left\{\frac{p_tc_t}{h_t} - \frac{1}{h^*}, 0\right\} + \psi_d d^* \max\left\{\frac{p_tc_t}{d_t} - \frac{1}{d^*}, 0\right\}. \tag{6}$$

The last line has a particular functional form for the transaction cost that will lead to closed forms. It introduces two parameters, ψ_h and ψ_d, measuring how important currency and deposits are in making transactions, respectively. Given the increasing dominance of digital forms of payment, we think of $\psi_h \approx 0$.

3.1.4 Non-financial firms

The production side of the economy consists of firms operating a simple technology that transforms one unit of labor into A_t units of output y_t. Their profits, which they rebate as capital income to the household, are: $p_ty_t - w_tl_t$. Because of some market power, driven by costs of entry, firms are able to charge a fixed markup $\mu_t > 1$ over their marginal cost. Therefore, if they could set prices to their desired level, they would choose a price of μ_tw_t/A_t.

We consider a simple form of nominal rigidity. In period t, only a fraction of firms λ is able to charge this desired price. The remaining firms instead are constrained to choose the same price as they had in place in the previous period adjusted by the inflation target. The simplest way to think about this constraint is that the expected wage in period $t+1$ is the same as that in period t (adjusted by the inflation target), so firms expected their optimal price to be unchanged, and did not update their information. As a result, there is a Phillips curve in period $t+1$, linking inflation to marginal costs:

$$p_{t+1} = \frac{\lambda\mu_{t+1}w_{t+1}}{A_{t+1}} + \frac{(1-\lambda)\mu_tw_t\pi^*}{A_t}. \tag{7}$$

3.1.5 Financial firms

Financial intermediaries—banks for short—receive at the start of each period an exogenous net worth from savers $\bar{n}$, maximize profits, and return their net worth to their owners as capital income at the start of the following period. They issue deposits to households as liabilities, and hold government bonds and central bank reserves as assets, so their budget constraint is $n_t + d_{t+1} = q_t b^f_{t+1} + v_{t+1}$. Strictly speaking, these are therefore narrow banks.

Each bank individually tries to maximize its net worth next period. Their income comes from collecting payment on the bonds and interest on reserves, as well as possibly a transfer s^f_t. (They could also hold currency, but would never choose to do so as long as $i^v_t > 0$.) Their expenses are the interest on deposits. Therefore, final net worth of the banking sector after payment of dividends is:

$$n_{t+1} = (1 + i^v_{t+1})v_{t+1} + \delta_{t+1} b^f_{t+1} - d_{t+1}(1 + i^d_{t+1}) + s^f_{t+1}. \tag{8}$$

Banks face two constraints in maximizing these profits. The first is a leverage constraint. The amount that banks promise to repay, and hence the constraint on deposits (their only liability), must be less than a fraction $\gamma < 1$ of what their net worth would be if they did not pay them. The implicit assumption is that only a share γ of the net worth pre-dividends can be pledged against the loan. Therefore:

$$(1 + i^d_{t+1})d_{t+1} \leq \gamma(n_{t+1} + (1 + i^d_{t+1})d_{t+1} + \zeta n_t). \tag{9}$$

Financial regulation that imposes a leverage constraint would enforce this as well.

Second, they have a reserve requirements constraint

$$\theta d_{t+1} \leq v_{t+1}, \tag{10}$$

where $\theta < 1$ is the reserve requirement. This could be imposed by regulation, or arise from a share θ of depositors having to withdraw their deposits within the period. Reserves are the ultimate means of payment in an economy so they are instantaneously liquid, while the market for bonds is (slightly) less liquid, opening only at the end of the period.

3.1.6 Markets

Combining all the pieces, the market for government bonds must clear, as they are held by households, financial firms, and the central bank

$$b_t = b_t^p + b_t^f + b_t^c. \tag{11}$$

Output is used for consumption of both agents, to pay for the transaction costs of the savers, and to supply public goods, so market clearing is:

$$c_t^h + c_t + \Psi_t c_t + g_t = y_t. \tag{12}$$

Finally, the transfers, some of which are helicopter drops, can go to spenders, savers, or banks:[7]

$$s_t = s_t^h + s_t^p + s_t^f. \tag{13}$$

The full set of equations that define a competitive equilibrium in this model are presented in the appendix.

3.2 The channels of monetary policy in the model

The central bank controls the interest paid on reserves i_t^v and the stock of the two types of public money h_t, v_t. These policy choices transmit to the real economy through multiple channels.

The transmission of interest rates: Let $1 + i_{t+1}$ be the expected return on the short-term bonds. Since the bonds are expected to be honored in full,

$$1 + i_{t+1} = \frac{1}{q_t}. \tag{14}$$

This is what would be commonly referred to as the nominal interest rate in the economy. It is determined in market equilibrium.

Now, if v_{t+1} is large enough, and the banks' reserve requirement constraint does not bind, then the banks will be indifferent between buying bonds or holding reserves. A

[7]They could also go to firms, but they would be instantly rebated to their owners, the savers.

no-arbitrage condition must hold:

$$1 + i_{t+1} = 1 + i^{v}_{t+1}. \tag{15}$$

This condition describes the standard modern transmission of monetary policy, where by setting the interest rate on reserves, the central bank effectively controls the market nominal interest rate in the economy. In turn, all other interest rates will vary with the nominal interest rate, since all other equilibrium conditions depend on spreads relative to i_t.

The interest-rate channel: The Euler equation from savers' optimal behavior is:

$$\frac{1 + i_{t+1}}{\pi_{t+1}} = 1 + r_{t+1} \equiv \left(\frac{c_{t+1}}{\beta c_t}\right) \left(\frac{1 + \Psi_{t+1} + c_{t+1}\partial\Psi_{t+1}/\partial c_{t+1}}{1 + \Psi_t + c_t\partial\Psi_t/\partial c_t}\right). \tag{16}$$

The right-hand side is a (shadow) real interest rate. The first term is the standard one that higher consumption growth is associated with a higher real interest rate. The second term arises from the transaction frictions. If demand for liquidity were satiated, it would just be equal to one. But, insofar as there are transaction costs in the future relative to the present, this raises the cost of savings for consumption and so the real interest rate must be higher for agents to save the same amount.

This equation is therefore the Fisher condition that captures the interest-rate channel of monetary policy.[8] If inflation is higher, for a given nominal interest rate, then real interest rates are lower, so that for fixed consumption tomorrow, consumption is higher today. Alternatively, as long as the central bank is able to steer the nominal interest rate in response to changes in the shadow real rate, it will be able to keep inflation on target.

The price-stickiness channel: Assuming that the demand for liquidity is satiated in both periods and that prices are flexible, then combining labor supply with the optimal pricing rule would imply that household consumption is $c_t = A_t/(\alpha\mu_t)$. This is independent of monetary policy. Consumption is higher in a more productive economy, where there is more competition, and if working is less costly.

Starting from this classical dichotomy at t, in the next period, the presence of nominal rigidities imply that there is a Phillips curve, a positive relation between inflation and

[8]In the literature on helicopter money, this channel plays a central role in Ball (2008), English et al. (2017), Harrison and Thomas (2019), Benigno and Nisticò (2020).

household consumption. The Phillips curve is:

$$\frac{(1-\lambda)\pi^*}{\pi_{t+1}} = 1 - \left(\frac{\lambda \mu_{t+1}\alpha}{A_{t+1}}\right) c_{t+1}. \tag{17}$$

Higher consumption means upward pressure on wages, which raises marginal costs, and thus inflation relative to its target.

This is the new Keynesian channel through which monetary policy, by affecting inflation, affects consumption and other real outcomes.[9]

The monetarist channel: The equations describing the demand for the two types of money are:

$$d_{t+1} = \begin{cases} p_{t+1}c_{t+1}\sqrt{\frac{\psi_d d^*}{i_{t+1}-i^d_{t+1}}}, & \text{if } i_{t+1} - i^d_{t+1} > \frac{\psi_d}{d^*} \\ p_{t+1}c_{t+1}d^*, & \text{otherwise} \end{cases} \tag{18}$$

$$h_{t+1} = \begin{cases} p_{t+1}c_{t+1}\sqrt{\frac{\psi_h h^*}{i_{t+1}}}, & \text{if } i_{t+1} > \frac{\psi_h}{h^*} \\ p_{t+1}c_{t+1}h^*, & \text{otherwise} \end{cases} \tag{19}$$

Starting with deposits, the lower is the spread between what the household earns on them, and what she expected she could earn holding government bonds, the more deposits she wants to hold. When the spread gets small enough, the demand gets satiated and, after that, insensitive to the interest rate. The same applies to currency, but in this case the spread is just the nominal interest rate itself, since currency earns no interest.

The transaction costs are:

$$\Psi_{t+1} = \psi_h \max\{\sqrt{h^* i_{t+1}} - 1, 0\} + \psi_d \max\{\sqrt{d^*(i_{t+1} - i^d_{t+1})} - 1, 0\}. \tag{20}$$

Therefore, the higher the nominal interest rate, all else equal, the higher the transaction costs in the economy. If there is enough money in the economy, in its two forms, then demands are satiated, and there is no cost. For this to be so, the nominal interest rate has to be sufficiently low, the general insight that is often called the Friedman rule.

This is the third transmission channel for monetary policy in this economy. By affecting the stocks of money, monetary policy affects interest rate spreads, and in turn

[9] In the literature on helicopter money, this channel plays a central role in Galí (2020a) and Carter and Mendes (2020).

the transaction activity in the economy. These transaction costs in turn will then affect real interest rates, as well as marginal costs, because they change the marginal utility of consumption.[10]

The deposit channel: Households defined an upward-sloping supply of deposits in equation (18), as a higher i^d meant households wanted to hold more deposits. The leverage constraint of banks will bind if $i^d_{t+1} < i_{t+1}$. In that case:

$$d_{t+1} = \left(\frac{1}{\frac{1+i^d_{t+1}}{\gamma(1+i_{t+1})} - 1} \right) \left(n_t + \frac{1}{(1+i_{t+1})} s^f_{t+1} \right). \tag{21}$$

This defines a downward sloping demand for deposits by banks: the higher is i^d the lower is d. The intersection of demand and supply defines the equilibrium d and i^d, noting that because the demand curve has a horizontal segment, once $i^d = i$, the quantity is fixed by d^*, and the constraint stops binding.

Alternatively, with scarce reserves, the reserve requirement may be the one binding. In that case $\theta d = v$ is the vertical supply of deposits that demand must intersect. In this case, also $i^v < i^d < i$: reserves are so valuable that they earn a large liquidity premium, beyond the one earned by deposits.

Either way, changes in the interest on reserves, or on the supply of reserves, transmit themselves to changes in deposit rates and to the total amount of deposits in the economy, which in turn affect transaction costs.[11]

3.3 Helicopter drops and suctions

In terms of the notation of the model, the definition of helicopter money requires:

1. an increase in money $v_t + h_t$,
2. that is dropped on the private sector raising s_t.

The discipline of having a model reveals that this definition is incomplete as a description of policy. It misses dynamics, explaining what comes next for the liabilities of

[10] In the literature on helicopter money, this channel plays a central role in Friedman (1969) and Harrison and Thomas (2019).

[11] See Borio et al. (2016) for the effect of helicopter drops on financial intermediation.

the central bank. This is important because the central bank can issue reserves and banknotes and drop them freely, but for people to get down to pick them up from the floor, they must have some real value. They are private assets, so there must be some hope of eventually redeeming them for consumption goods. This is only the case if reserves or banknotes are not a Ponzi scheme.

This is easier to see mathematically if we assume there are only two periods, 0 and 1. In that case, the (transversality) final-period optimality condition for households and banks, combined with market clearing imposes that

$$b_2 - b_2^c + (1 + i_2^v)v_2 + h_2 = 0 \tag{22}$$

The final money in the economy, $v_2 + h_2$ is pinned down by this equation. Therefore, a helicopter drop that exogenously raises $v_1 + h_1$ cannot persist. The drop must be followed by a suction. This equation also makes clear that the suction may be of money, but it is also possible that it is a fiscal suction. If money is permanently dropped, then government bonds b_2 must fall in the opposite direction. In fact, this may be part of the way the drop is implemented in the first place, with the central bank issuing money to buy government bonds that it holds forever, so that money $v_2 + h_2$ rises forever and bonds held by the public $b_2 - b_2^c$ fall forever by just as much.[12]

It should be immediate to see that if there is an arbitrary final period T, the same argument applies. The condition is $b_{T+1} - b_{T+1}^c + (1 + i_{T+1}^v)v_{T+1} + h_{T+1} = 0$, so after the helicopter drop at 0 raising $v_0 + h_0$, then before the end of the world the government liabilities must fall. With an infinite horizon, the suction only happens at infinity, and so arguably never, but the point remains: while each branch of the government can run a Ponzi scheme on the other, collectively they cannot run one on the private sector. Only then will the helicopter drop something that has real value, even if in the infinite future. But then, with any free drop of a liability, there must be a suction somewhere else, in exchange for real resources.[13]

[12] Quantitative easing, which consists of issuing v_t to buy $q_t b_t$ within the same period, keeps unchanged the overall public liabilities that the private sector holds if the demand for reserves is satiated, on impact and at all dates, so no future suction is needed.

[13] A similar argument applies to quantitative easing. If the central bank holds government bonds to maturity, and then keeps rolling them over, even if only at infinity, the total public liabilities are unchanged.

3.4 The impact of the drop on public resources, across the two branches of the State

The possibility of helicopter drops of money followed by fiscal suctions raises the perennial point that one needs to describe the link between monetary and fiscal policy to understand the effects of either. Sticking to the two-period case for transparency, the intertemporal budget constraint of the central bank is:

$$x_1 = v_2 + h_2 + i_1^v h_1 + [\delta_1(1+i_1) - (1+i_1^v)](v_1+h_1) + \delta_1(1+i_1)e_0. \tag{23}$$

The central bank gets to the end of its life and it can rebate to the fiscal authority all of its net worth, which has four components: (i) the (potentially Ponzi-scheme) liabilities it leaves, (ii) the seignorage it earns by being able to issue some liabilities (currency) that pay a lower interest rate than the others, (iii) the excess returns on its portfolio, which will be zero if reserves are satiated and $\delta_1 = 1$ (as expected), (iv) the return on the net worth it started with.

The intertemporal budget constraint of the fiscal authority in turn is:

$$x_1 + q_1 b_2 = \delta_1(1+i_1)(b_0 + g_0 + s_0) + \pi_1 g_1 + s_1. \tag{24}$$

The sources of funds are dividends from the central bank and Ponzi-debt; the uses are paying interest on initial debt, and the present value of spending on purchases and transfers (that can be negative).

Another potential channel for helicopter money is if it changes the resources available to either of these two branches of the State, loosening or tightening these budget constraints. It is important to distinguish between two separate cases.

First, if the central bank is fiscally independent, then there will be a constraint on what values the x_1 can take (Reis, 2019). It may well be negative, as central banks can have a negative net worth. Independence means that the central bank cannot be forced by the fiscal authority, or "dominated", to produce some amount of net income that will pay for fiscal deficits. In that case, while both money and government bonds are public liabilities, the fact that they are issued by different branches of the government means that they may have different effects. Fiscal transfers tighten the budget constraint of the government, while helicopter money loosens the budget constraint of the central bank.

Second, if instead there is unlimited fiscal backing, $x_1 \in \Re$. Then, we can combine the two equations to write a single budget constraint for the whole government:

$$[\delta_1(1+i_1)-(1+i_1^v)](v_1+h_1)+i_1^v h_1=\delta_1(1+i_1)(g_0+s_0)+\pi_1 g_1+s_1-\delta_1(1+i_1)(e_0-b_0). \tag{25}$$

The two terms on the left-hand side show the two ways in which a helicopter drop potentially relaxes the constraint on the resources of the government as a whole. Either it does so because the new money pays a lower interest rate than the ex post return on government bonds, so that by borrowing using the central bank as opposed to the Treasury, the government gets a better deal. Or it does it if the new banknotes generate seignorage because the nominal interest rate is positive.

4 The neutrality or not of helicopter money

Consider the following set of conditions:

1. Helicopter money raises the supply of a form of money for which demand is satiated.

2. Conventional monetary policy can adjust so that inflation is kept on target.

3. The money drop does not redistribute permanent income across private agents.

If these hold, helicopter money is neutral.

Intuitively, the first condition dictates that the monetarist and deposit channels of monetary policy are unaffected by the helicopter drop. The household is satiated with deposits or banknotes, so that when the helicopter drop changes the supply of these forms of liquidity, this has no effect.

The second condition says that the interest-rate and price-rigidity channels are likewise not at play. The central bank is still able to use the interest on reserves to affect the nominal interest rate, and through it, it keeps inflation on target and the output gap closed.

Finally, the third condition says that beyond macroeconomic aggregates, the helicopter money did not change the resources of individual agents. Therefore, it will not change their choices.

4.1 A two-period formalization

It helps the discussion that follows to simplify to the case when: (i) there are only two periods, $t = 0, 1$, with the helicopter dropping at the first date, (ii) the initial price level is normalized to 1, $p_0 = 1$, (iii) since money at date 0 is pre-determined and unaffected by policy, $\Psi_0 = 0$, which would correspond to an initial situation when the demand for deposits is satiated and the transactions costs of currency are negligible.

Restating the neutrality results while walking through the proof, consider then that the helicopter drop took the form of a temporary increase in reserves v_1, used to buy government bonds $q_0 b_1^c$, with the government using the revenue to make a transfer to savers s_0^p. The interest on reserves i_t^v was unchanged, as were transfers to the other agents in the economy s_t^f, s_t^h. Mathematically, since the demand for deposits was satiated $d_1 = p_1 c_1 d^*$, then the interest rate on deposits was equal to the nominal interest rate $i_1^d = i_1$. But then, it must be that $i_1 = i_1^v$ so the leverage and reserves constraints of the banks are slack. Therefore an increase in v_1 has no effect on d_1 whatsoever, neither on the transaction frictions Ψ_1.

Moreover, because the interest on reserves is unchanged, so are all interest rates in the economy, as well as inflation. Therefore, in the Phillips curve, the consumption of savers is unchanged.

Next, because there is no redistribution, the intertemporal constraint of the savers only changes insofar as the term $s_0^p + s_1^p/(1 + i_1)$ would change. But, because there is no redistribution within the public sector either, the integrated budget constraint of the government holds. Because $\delta_1 = 1$ and $i_1^v = i_1$, then v_1 does not appear anywhere in equation (25). Finally, the increase in s_0^p must come later with a fall in $s_1^p/(1 + i_1)$. Therefore, consumer choices do not change.

In conclusion, under these assumptions, helicopter money is completely neutral. Starting from this concrete example, the rest of this section will break this neutrality by deviating in turn from each of these conditions.

4.2 Improving liquidity by lowering transaction costs

Before 2008, in most advanced economies, the demand for reserves was not satiated. Rather, central banks kept the supply of reserves low, which implied that deposit rates were significantly lower than the nominal interest rate in the economy. Much of the older literature on helicopter money had this case in mind. Recent policy reviews and/or statements at the Federal Reserve, the Bank of England, and the European Central Bank affirm that in the near future this will not be the norm. However, the old regime continues to play a role in textbooks and through them in some discussions of helicopter money.

Imagine, going back to the old regime, that the reserve requirement constraint binds, so v_1 is too small. In this case, the increase in reserves v_1 will raise the supply of deposits by banks d_1, as it improves their ability to create those deposits. Given the demand curve, this raises the interest rate that the banks offer in the deposits, i_1^d. Therefore, it lowers the spread $i_1 - i_1^d$, which is the liquidity premium of deposits. This lowers the transaction cost Ψ_1. Consumption therefore rises because net output rises: the economy is more efficient at making transactions. This effect is due to issuing more reserves to an economy that is starved of them. The key result is that helicopter money reduces the liquidity premium in the economy.

If, instead, the reserve requirement does not bind but the leverage constraint does, then the increase in v_1 has no effect on i_1^d or on d_1, so it continues to be neutral. Therefore, there being a liquidity premium for deposits in the economy is not sufficient for helicopter money to have an effect. To break the neutrality of helicopter money, there must have been a reserve liquidity premium.

There is a final case in which helicopter money would affect transaction costs, even if the demand for reserves is satiated. The helicopter can carry and drop currency h_t instead. As long as nominal interest rates are not too low, the demand for banknotes will not be satiated. By increasing the supply of a scarce asset, the central bank can directly lower transaction costs in the economy.

However, there is also an indirect effect in this case. The increase in the supply of banknotes causes a fall in their opportunity cost, the nominal interest rate i_t. Unlike reserves, the central bank does not set an interest rate on banknotes. The helicopter drop of banknotes will then make deposits less profitable, tighten the leverage constraint, and decrease the supply of deposits. The liquidity associated with digital payments actually falls, even as the liquidity associated with banknotes rises. This then raises the transactions costs from using deposits for payments. Insofar as ψ_h is small, as we assumed, this negative indirect effect outweighs the direct effect. Therefore, a helicopter drop of banknotes may actually end up raising transactions costs in the economy.

4.3 If conventional monetary policy can no longer achieve the inflation target

The case where non-satiated banknotes are issued is famous in economic theory for a reason beyond transaction costs. It also violates the second condition for neutrality, since it raises inflation, something that did not happen when the helicopter drop was introduced via an increase in reserves.

The reason is that, when it created reserves, the central bank could adjust the interest paid on them. Therefore, through conventional monetary policy, inflation could stay on target. With banknotes though, the central bank does not have such a tool. The increase in h_t implies an adjustment on i_t in the market for banknotes. With it follows a change in inflation, and because of nominal rigidities, this will also come with a change in output, consumption, and welfare.

Using interest-rate policy to actively control inflation requires supplying currency elastically. The supply of currency h_t has to respond to the demand for it, so the central bank is no longer able to exogenously set h_t. A central bank that exogenously chooses to just issue banknotes and drop them will find that it can no longer exogenously steer nominal interest rates, and that the drops will affect inflation. In other words, a central bank that wants to helicopter drop banknotes is one that has to give up conventional monetary policy. Banknotes and interest rates cannot be simultaneously used.

There is a second case where a helicopter drop makes the inflation target no longer attainable, even if reserves are what is dropped. That happens if there is a constraint on x_1, the fiscal backing of the central bank, namely if the government does not recapitalize the central bank. In this case, the extra reserves can lead to a form of fiscal dominance of monetary policy.

To see it, say for concreteness that the constraint on fiscal backing is that $x_1 = \delta_1(1 + i_1)e_0$, so the central bank must return the net worth it started with to the government. Similarly, imagine that $b_2 = 0$, so the government refuses to honor any reserves left by a permanent helicopter drop. In that case, the intertemporal budget constraint of the central bank becomes:

$$i_1^v h_1 = -[\delta_1(1 + i_1) - (1 + i_1^v)](v_1 + h_1). \quad (26)$$

After an exogenous increase in v_1, if the ex post return on the government bonds is lower than the interest paid on these new reserves, then the central bank will make a loss.

The right-hand side of this equation will be positive, and the only way for the central bank to cover this loss is to increase seigniorage by raising h_1, that is, printing banknotes to raise the left-hand side. Of course, this will come with inflation above the target. The initial helicopter drop created a loss for the central bank, that it had to fill by letting inflation rise in order to increase seigniorage revenues.

Finally, there is a third, more extreme, case in which the helicopter drop may cause (hyper)inflation. So far, we assumed that the increase in reserves was temporary, so the rise in v_1 was still consistent with a fixed (likely zero) v_2. Imagine instead that reserves are permanently higher. How can the central bank get banks to hold reserves at the end of the world? This would be consistent with inflation on target only if on the other side the government lends to agents the resources, so $q_1 b_2 = -v_2$, as we discussed before.

But imagine this does not happen. Then, agents would see the extra reserves dropped on the sidewalk, realise they are a Ponzi scheme that will never be repaid, and thus leave them there as they would be worthless. As reserves are the unit of account, for them to be worthless, then the price level must be infinity. This example, while extreme, is instructive because it shows that under central bank independence and limited fiscal backing, avoiding hyperinflation requires some monetary-fiscal coordination in the operation of the suction of government liabilities that follows the central bank's helicopter drop.

4.4 If the helicopter drop leads to redistribution

When money gets dropped from the sky, it is quite unlikely that everyone will receive the same amount as a proportion of their permanent income. It is well beyond the remit of any advanced central bank to pick winners and losers and this clearly highlights the hybrid nature of a helicopter drop: it needs a fiscal authority to carry out the transfers. And, indeed, many of the arguments for helicopter money as a joint monetary-fiscal operation rely on the ability to make fiscal transfers that are differentiated across groups.

Going back to the case where the helicopter drop comes through an increase in reserves v_1, and this market is satiated, consider now the case where they are not dropped to savers, but rather to the spenders in the economy, so s_0^h increases. Their consumption automatically rises in period 0, and they are better off. But who loses?

This depends on who later sees their transfers cut. Recall that the mechanics of helicopter drops are that the central bank issues reserves to buy the government bonds that result from the initial transfer. In period 1, the government must pay the bonds back to the central bank. It must raise taxes, or cut transfers to do so. If it cuts transfers to the spender households, then helicopter money just changed the profile of their consumption: increasing consumption in period 0, and lowering it in period 1. Maybe this made them better off, maybe not, but the other households' welfare is unchanged.

Alternatively, perhaps the helicopter drop to the spenders in period 0 came with a drop in the transfers to saver households in period 1. In that case, the savers are obviously worse off and spenders are better off. Helicopter drops, rather than manna from heaven, are a form of redistribution from some households to others.

A separate case is if the drop is given to banks, so s_0^f rises. (Note that this would be a direct transfer to banks, different from quantitative easing, which entails a swap of assets from the banks' perspective.) Start with the case where the leverage constraint is slack. Then, whether the reserve requirement is slack or binding, the transfer is neutral, since banks simply rebate back the transfer to their owners as dividends. Thus, the money dropped makes its way back to the saver households, and we are back to the neutrality case.

If instead the leverage constraint binds, then the drop relaxes this constraint. This leads to an increase in deposits and raises the deposit rate. If the deposit market is also not satiated, then the drop lowers transaction costs and increases consumption. Using helicopter drops to transfer to bankers is only effective if the net worth of the bankers is the scarce resource.

The crucial lesson is that no matter who gets the helicopter money, the questions of whether they ultimately win or lose comes to who pays for the higher taxes or lower transfers in the future. After all, what is dropped is a liability of the government that will sooner or later be redeemed into real resources.

5 Helicopter drops in response to shocks

Proposals for helicopter drops often do not come in isolation, or as a policy to be used at all times. Rather, the drops are proposed as a response to other shocks or to particular challenges that the economy is going through.

To discuss these within our simple model we keep the assumptions of two periods and perfect foresight, so that everyone in the economy at date 0 believes that none of the exogenous variables will ever change. However, at date 0, an unexpected shock occurs in the form of a sudden change. We will consider the following shocks: (i) an unanticipated increase in government spending g_1, (ii) a fiscal crisis with sovereign default $\delta_1 < 1$,

(iii) a supply shock causing a recession as μ_1 rises or A_1 falls, (iv) a dash for cash in the economy as ψ_d rises, and (v) a financial shock tightening the supply of deposits, either through lower γ or θ.

5.1 Is a helicopter drop an answer to the zero lower bound?

Since the global financial crisis, most advanced economies have gone through long periods with nominal interest rates close to zero. The decline in real interest rates over the past three decades (or more), together with anchored inflation expectations, makes it likely that this will continue to be common. If the interest on reserves is close to its effective lower bound (ELB), then the central bank may find it impossible to use conventional monetary policy alone to keep inflation near its target. In that setting, helicopter drops have been proposed as a plausible alternative.

In our simple model, there is an ELB and it equals ψ_h/h^*. Since ψ_h is very close to zero, this ELB is a zero lower bound. The reason is that, because banknotes pay a zero interest, in our simple setting there is no equilibrium such that $i_t < 0$. This would involve an infinite demand for these banknotes to avoid the sure losses from holding government bonds or reserves instead. Slight changes in the functional forms we assumed could easily extend this argument to moderately low nominal interest rates. Similarly, considering some of the inconvenience, storage and insurance costs of holding cash (particularly in large amounts) vis-a-vis deposits, can drive the ELB below zero. For simplicity, we normalise those costs to zero in our considerations below.

The model can also accommodate the causes of lower interest rates. In a scenario where productivity A_1 is expected to fall very significantly, then the real interest rate on the right of equation (16) can be strongly negative. In that case, it may happen that the nominal interest rate i_t that would be consistent with the inflation target π^* is negative, which we rule out here by our assumptions above. As a large literature has shown (Rogoff, 2017, Eggertsson and Egiev, 2019), in this case the economy would enter a recession unless inflation can go above its target.

In principle, this is consistent with conventional monetary policy. Post 2010, the market for reserves has been (approximately) satiated. Monetary policy in many central banks is conducted by setting the interest on reserves, both contemporaneously as well as in the future through forward guidance, and by engaging in quantitative easing. In our model, these are enough to deliver whatever happens to be the desired inflation rate at date 0, including a higher rate. The ZLB makes the old inflation target no longer possible, but as long as the target is adjusted and firms incorporate the new publicized target in their pricing choices, no output gap will result. No helicopter money would be needed. The adjustment of the target, however, might not be a choice for the central banker in many jurisdictions.

A different problem arises in terms of the implementation of any new inflation target. So far in this paper, we simply assumed that the central bank was able to pin down the price level, and checked that the interest rate policy was consistent with this. We were silent about how the price level is determined in the first place. There is a long literature on this topic (Castillo-Martinez and Reis, 2019), and helicopter money plays a role in it.

For simplicity, assume that the real interest rate is a constant r^* across periods, so the Fisher equation in (16) is $1 + i_{t+1} = (1 + r^*)\pi_{t+1}$. Then, imagine that the central bank tries to implement its inflation target through a Taylor rule:

$$1 + i_{t+1} = \max\left\{(1 + r^*)\left(\frac{\pi_t}{\pi^*}\right)^{\phi}, 1\right\}, \tag{27}$$

where $\phi > 1$. Combining these two equations shows that inflation follows a difference equation.

One solution to the equation is that $\pi_t = \pi^* > 1$. But another solution is $\pi_t = 1/(1 + r^*)$, in which case the economy is stuck at the ZLB with deflation forever. It is not hard to show that this latter solution is the global stable one. In it, p_0 becomes indeterminate, since any level of the price level such that inflation is below the desired target, leads to a path in which inflation is falling and reaching the deflation stable state in finite time.

If the economy is stuck in this deflation trap, then abandoning conventional monetary policy and interest-rate control for a helicopter drop of banknotes can help. If the central bank sets the supply of banknotes below the satiation point, then the interest rate will be above zero. In turn, once the central bank chooses a path for h_t from then onwards, by standard monetarist principles, this will pin down a unique level of inflation. Somewhat more subtle, if the central bank chooses interest rates, but threatens to switch into monetarism if the economy enters a deflation trap, then this may be enough to coordinate the economy into the equilibrium where inflation is on target. In this case, the helicopter drop would never take place, but the threat that it would happen if deflation were to set in would be enough to prevent deflation in the first place.

In this case a helicopter drop would in effect be the first step in a switch from interest-rate to money-supply monetary policy. It is not so much the helicopter drop as it is this switch in policy regime that knocks the economy out of the deflation equilibrium. There are, however, three objections to taking this as a policy recommendation.

First, if the economy starts from zero interest rates then the demand for banknotes at that point is already satiated. An extra helicopter drop would have no effect.

Second, the historical experience with monetarism has been mixed. There are large shifts in the desire for banknotes (in terms of our model, large shifts in ϕ_h) which imply that the helicopter drops would have to be perennially fine tuned and bound to fail, leading to volatile inflation. Insofar as the helicopter drop would be such an unusual policy, one might also expect that the demand for banknotes would dramatically shift making its quantitative impact on inflation hard to gauge. There are many different models for the demand for banknotes, making it hard to judge which to use to guard against this version of the Lucas critique.

Third and finally, if the helicopter drop is used simply as an off-equilibrium threat, while keeping to conventional policy, then one must consider how credible this commitment is, and how forward looking private agents are in taking it into account. These are difficult questions when it comes to their implementation.

5.2 Is a helicopter drop the answer to a financial crisis?

The financial crisis of 2008-10 led to many unconventional (at the time) monetary policies, from explicit forward guidance to quantitative easing. After a decade, many of them were normalized, having been added to the standard toolkit of monetary policy. Helicopter drops of money were not one of them: they were never even tried. Should they have been?

A first important observation is that, before 2008, the market for reserves was not satiated in most advanced economies. Therefore, the conditions for neutrality of helicopter money did not hold. The policy would have had an effect. However, in response to the crisis, quantitative easing, by raising reserves v_t, satisfied the desire for liquidity during the crisis, and reduced the transaction costs associated with it. If this was an important feature of the crisis, then quantitative easing addressed it directly. Fiscal policy could carry out any transfers needed on its own, without requiring coordination or helicopter money.

Second, and related, imagine that a crisis corresponds to a sharp exogenous increase in θ as people run on banks, and they need to keep a higher share of their assets in reserves. All else equal, if the reserve constraint becomes binding, then this would lower the supply of deposits, increase the deposit liquidity premium in the economy, and lower consumption and welfare. The policy response to prevent this is to expand the supply of reserves. This could be done as part of helicopter money but, as was done in reality, doing it as part of quantitative easing (without tying the action to fiscal transfers) achieves the same goals.

Alternatively, imagine that a crisis is instead an abrupt decline in γ. Large losses that reduce the net worth of banks lead to the same effects. Both are associated with the leverage constraint that binds for banks becoming tighter. In this case, as equation (21) shows, a helicopter drop can be an effective response to the shock, as long as the money is dropped on the banks. The problem in this case is that bankers have too little net worth, and thus too little skin to offer for their skin-in-the-game constraint to allow them to produce deposits. Banks need to be recapitalized, a policy solution that is common in much of the literature on financial crisis (Gertler and Kiyotaki, 2010, Admati and Hellwig, 2014). Dropping new resources on banks through a helicopter would be one way to inject capital in the banks. In practice, such a handout to banks may not be politically popular.

5.3 Is a helicopter drop the answer to a fiscal crisis?

From the perspective of a fiscal authority, the idea of paying for government spending with money, as opposed to government debt, is understandably appealing. It is likewise not surprising that, in light of the debates around austerity in the last decade, and the historically high government debt, there are calls for helicopter drops as a way to relax the budget constraints of the government. Particularly in a fiscal crisis, this appeal is only stronger.

A first version of a fiscal crisis is an austerity shock, understood as a sudden an unexpected fall in government purchases g_1. In our economy, this leads to a fall in output, as in standard new Keynesian environments. The fall in the demand for goods, combined with the stickiness of prices, implies that inflation and output both fall in response. A helicopter drop, if the neutrality conditions do not hold, could help stimulate the economy.

At the same time, conventional monetary policy could instead be used. If the only goal is to stimulate real activity to fight a recession, whether that was caused by austerity or some other shock, then changes in interest rates are a tested and tried way for monetary policy to stabilize real activity. (This might not be, however, sufficient to push back demand to its potential, which might put into question the inevitability of the austerity shock and lead to the exploration of fiscal policy solutions.)

A second version of austerity would be a cut in transfers s_t. Most modern fiscal policy packages consist of changes in transfers, which are both the lion share of government budget and the part that is more cyclical and more subject to discretionary changes (Oh and Reis, 2012). In this case, it is almost obvious that a helicopter drop to the group that suffered a cut in transfers would neutralize the effects of the fiscal policy.

Of course, as we discussed in section 4.4, this raises the question of whose transfers would then be cut in the future to be able to evaluate who are the winners and losers. More pressing, it is difficult to see the legitimacy of the central bank undoing a redistribution enacted by the Treasury.

A third case to consider is a fiscal crisis as a shock to δ_1, an unexpected default on the public debt. In a closed economy like ours, the result of a default is an ex post redistribution from the holders of the debt. The central bank is one such holder. Therefore, it suffers a loss, and might even find itself with negative net worth at the end of time. However, the gains of the fiscal authority are the losses of the central bank. With the fall in central bank dividends x, perhaps becoming negative, there are two possible scenarios. If the central bank is fully fiscally backed, the government will recapitalize it so that it can honor reserves. Since the size of this recapitalization rises precisely with the size of the helicopter drop, then in fact the fiscal authority's intertemporal budget constraint is unchanged.[14]

If instead, the government does not recapitalize the central bank, then, as discussed in section 4.3, inflation will increase. This is either because the central bank resorts to issuing banknotes to increase seignorage, or because if it does not, reserves become a Ponzi scheme and hyperinflation results. Neither are per se helicopter drops.

A final case does not fall within the domain of our model, but can still be discussed. If there is a single central bank, but multiple fiscal authorities, then through helicopter drops, the central bank can redistribute across these fiscal regions. Even if the neutrality conditions hold, because banknotes and reserves are a common liability, whereas the transfers would go to a single region, there would be a redistribution across regions. Similarly, if one region defaults on its debt, which the central bank was holding, again this is a redistribution from the other regions to that region, as long as all will receive less dividends from (or recapitalize equally) the central bank in response to these losses (Reis,

[14] This same logic would apply to quantitative easing. If the central bank issues reserves to buy government bonds, and government proceeds to cancel these government bonds (effectively having $\delta_1 = 0$ only for the bonds that the central bank holds) this would monetize the debt. However, it does not loosen the intertemporal budget constraint of the fiscal authority, who now collects smaller dividends from the central bank. No fiscal transfers take place, so there is no helicopter drop associated with the government default.

2013).

5.4 Is a helicopter drop the way to finance a major public investment?

A major challenge facing many economies is how to deal with the existential threat of climate change. Helicopter drops per se would have little to do with carbon emissions or the use of natural resources. But, insofar as the climate challenge requires large public investments to green the economy, in public debates sometimes the proposal is floated of paying for these with helicopter money.

The theory in this paper, as well as in most models of helicopter money, suggest that this would not work. The helicopter is dropping a public liability, that still needs to get paid in the future. Public liabilities are not net wealth. In the sense of Ricardian-equivalence, they do not make private agents richer if they have to pay for them with higher taxes in the future. Recall, as emphasized in section 3.4, that the helicopter drop must be followed by a suction, monetary as well as fiscal, as no new resources are being created.

Alternatively, for there to not be a suction, the helicopter drop must generate some resources. The only way it can systematically do so is if the money being dropped was scarce, and so earned a liquidity premium which becomes a revenue for the central bank. The clearest case in which this happens is if the central bank issues new banknotes. These generate seignorage, as long as the nominal interest rate is positive. However, the drop implies that these are transferred directly to the private sector. If the goal of printing money was to relax the budget constraint of the government, then the money should not have been dropped. Rather, it should have been used directly to pay for the government purchases. This is sometimes called monetary financing of the deficit. By dropping it on the private sector, the helicopter is not helping to finance new public investments.

5.5 Is a helicopter drop the response to a pandemic?

The pandemic recession in 2020 posed deep challenges to almost every economy in the world.

Early in the pandemic, during the first lockdown, there was a "dash for cash" as people and firms increased their demand for liquid forms of payments worried that they would need them to keep expenses during a period of little income. In our model, these can be seen as increases in ϕ_h or ϕ_d. To offset them, central banks behaved as our model would advise, raising v_t and h_t so that the demand for liquidity would stay satiated and interest rates did not rise. This response to a dash for cash is the standard textbook answer to liquidity management. There was no helicopter drop as there was no transfer.

At the same time, the pandemic induced a very large recession. We can understand it as a mix of a fall in A_t or rise in μ_t, with at the same time a fall in demand, which in the model would appear as a fall in g_t. The combined result, beyond the fall in output, was at first a fall in inflation. Central banks swiftly cut interest rates, carried out quantitative easing, and resorted to forward guidance on rates. In effect, they addressed the second condition for neutrality of helicopter drops, using conventional monetary policy to keep inflation close to target.

Finally, during the Spring and Summer of 2020, the central banks of many economies greatly increased the supply of reserves v_t. These were used to buy government bonds, effectively lowering longer-term yields (not modelled in our paper). This lowered borrowing costs for the whole economy, both the private and public sector, helping boost demand in sectors that could operate safely, while reducing the scope of scarring (also outside of our model). Governments were at the time also increasing transfers (in the form of unemployment insurance, payroll protection, and a myriad other programs) to households s_t. While monetary and fiscal policy were both following their own, independent objectives, by responding to a common shock, their simultaneous actions can be, if added together, stretched into the description of helicopter drops, since both conditions of our definition are satisfied. Their combined actions were not neutral because fiscal policy effectively redistributed resources, both across households and from the future to the present.

The experience of the pandemic also shows how important is the potential follow-up "suction" dimension of the operation in the future, once the need for a monetary policy stimulus wanes. Accordingly, many central banks have started thinking of strategies to unwind their quantitative easing programmes when their economies normalise. This would correspond to the increase in reserves being temporary: in the notation of our model, a positive $v_1 - v_0$ followed by a negative $v_2 - v_1$. The effect of the helicopter money was not to relax the resource constraint of the government: there was no direct monetary financing. Rather, it worked through redistribution. But it was the fiscal authority that took charge of the redistributive decisions on who should be supported more or less. Central banks could focus on their remits, retaining their ability to hit their targets.

5.6 Is a helicopter drop the future of conventional monetary policy with CBDC?

There is an active debate on the introduction of central bank digital currencies (CBDC) as a step forward in the evolution of payment systems. Several central banks have announced their intentions to implement some version of CBDC in the near future. [15]

There are many implications of CBDC and, correspondingly, ways to model them. One simple modification of our model is to consider a world in which banks become solely vehicles through which households hold deposits at the central bank. Neither the leverage nor the reserve constraint on banks now hold, since they issue deposits and hold them entirely at the central bank, $v_t = d_t$. Banks would pay the interest they receive from the central bank directly to the depositors, $i_t^v = i_t^d$, and so earn zero profits; hence, their net worth and returns to the savers asymptotes to zero. Recall that the only function of banks in our economy was to provide liquidity, they were narrow banks that provided no credit to firms. The government bonds they used to hold are now held instead by the central bank. For all purposes, in our model, banks are no longer relevant, since reserves effectively become a central bank digital currency (CBDC) held by the households.[16]

The mechanics of a helicopter drop now become simpler. A helicopter drop that raises the supply of reserves may lower transaction costs insofar as the demand for deposits in the economy was not satiated. It need not lead to inflation as long as that demand is satiated and the central bank continues to set i^v. Nothing in the analysis changes.

A second change that CBDC might make is that it would allow for easy and targeted helicopter drops. The central bank can simply credit those accounts, instantaneously dropping the new money, as opposed to waiting for their distribution as (slow) fiscal transfers. Moreover, insofar as the new digital accounts have information on their holders, targeting those transfers may also become easier. It becomes feasible for the central bank to pilot the helicopter. At the same time, it is important to note that under their current mandates, the central banks could not decide whether to make those transfers or to target them. The fiscal policy would still need to provide the map and the itinerary to the helicopter pilot.

In terms of the model, the s_t would now enter the central bank's budget constraint.

[15] For an analysis of CBDC, see Auer, Frost, Gambacorta, Monnet, Rice, and Shin (2021).

[16] Another way to think of CBDC is as an alternative to banknotes (h) as opposed to deposits (d). If so, and the CBDC does not pay interest but provides a transaction service distinct form banknotes, nothing changes in our analysis aside from interpreting h as CBDC.

Otherwise, in economic terms, little changes relative to our analysis. Perhaps CBDC makes helicopter money easier to implement, while at the the same time raising issues on the autonomy and legitimacy of the central bank to do so. Economically, it makes little difference within our stylised model.

6 Conclusion

We revisited Milton Friedman's idea of helicopter money, using a stylised model to capture a number of potential channels of policy transmission. The model helped to organise a taxonomy of different possibilities that determine the effectiveness of helicopter money interventions. To carry out our policy experiments, we first established neutrality conditions, that is, conditions under which helicopter money drops have no real impact on the economy. We then studied the economic effects stemming from deviations from those Ricardian conditions.

As the model makes transparent, a number of questions become critical in determining the impact of the policy: is the helicopter drop implemented as an increase of (non-interest-bearing) currency (or reserves) or interest-bearing reserves? Does the helicopter money drop cause a redistribution across agents? Is the market for reserves satiated? Is the central bank fully backed by the government? Does the central bank have tools to achieve its inflation target? After addressing those questions, we used the model to analyse and discuss the impact that helicopter drops might have in response to a number of economic shocks, including (stylised versions of) a financial crisis, a fiscal crisis and a pandemic, discussing different potential scenarios.

Our neutrality result clarifies the case for helicopter money. Given the current abundance of reserves and little use of banknotes, the case for helicopter money providing liquidity seems weakest. The case for using helicopter money to redistribute across agents in the economy may be the more powerful, but it is also the one that seems more at odds with current institutions. Using helicopter money to achieve an inflation target when conventional monetary policy is unable to do so may be the stronger case for it, subject to the caveats that our analysis raised.

The general lesson from this survey is that the appropriate response to a policy proposal for helicopter money is: "tell me more." What form of money, given to who, and with what accompanying policies? These, and more, make all the difference between this policy being completely neutral or potentially very powerful.

References

ADMATI, A. AND M. HELLWIG (2014): *The Bankers' New Clothes*, Princeton University Press.

AUER, R., J. FROST, L. GAMBACORTA, C. MONNET, T. RICE, AND H. S. SHIN (2021): "Central bank digital currencies: motives, economic implications and the research frontier," BIS Working Paper No. 976.

BALL, L., J. GAGNON, P. HONOHAN, AND S. KROGSTRUP (2016): *What else can central banks do?*, ICMB International Center for Monetary and Banking Studies.

BALL, L. M. (2008): "Helicopter drops and Japan's liquidity trap," *Monetary and Economic Studies*.

BARTSCH, E., J. BOIVIN, S. FISCHER, P. HILDEBRAND, AND S. WAN (2019): "Dealing with the next downturn: From unconventional monetary policy to unprecedented policy coordination," *SUERF Policy Note*, 105, 1–16.

BENIGNO, P. AND S. NISTICÒ (2020): "The economics of helicopter money," CEPR discussion paper No. 14555.

BERNANKE, B. (2016): "What tools does the Fed have left? Part 3: Helicopter money," *Brookings Blogs*, 11–4.

BLANCHARD, O. AND J. PISANI-FERRY (2019): "The Euro area is not (yet) ready for helicopter money," *The Peterson Institute of International Economics (PIIE) Blog*.

BORIO, C., P. DISYATAT, AND A. ZABAI (2016): "Helicopter money: The illusion of a free lunch," *VoxEU*.

BORIO, C. AND A. ZABAI (2016): "Unconventional monetary policies: a re-appraisal," BIS Working Paper No. 570.

BUITER, W. H. (2003): "Helicopter money: irredeemable fiat money and the liquidity trap," NBER Working Paper No. 10163.

——— (2014): "The simple analytics of helicopter money: Why it works — always," *Economics*, 8, 1–45.

CARTER, T. J. AND R. R. MENDES (2020): "The power of helicopter money revisited: A new Keynesian perspective," Bank of Canada Staff Discussion Paper No. 2020-1.

CASTILLO-MARTINEZ, L. AND R. REIS (2019): "How do central banks control inflation? A guide to the perplexed," LSE manuscript.

CUKIERMAN, A. (2020): "Covid-19, helicopter money & the fiscal-monetary nexus," CEPR Discussion Paper No. 14734.

DOWD, K. (2018): "Against Helicopter Money," *Cato Journal*, 38, 147–169.

EGGERTSSON, G. AND S. EGIEV (2019): "Fundamental Driven Liquidity Traps: A Unified Theory of the Great Depression and the Great Recession," Brown manuscript.

ENGLISH, W. B., C. J. ERCEG, AND D. LOPEZ-SALIDO (2017): "Money-financed fiscal programs: A cautionary tale," FEDS Working Paper No 2017-060.

FRIEDMAN, M. (1969): "The Optimum Quantity of Money," in *The Optimum Quantity of Money and Other Essays*, ed. by M. Friedman, London: MacMillan, chap. 1, 1–50.

GALÍ, J. (2015): *Monetary policy, inflation, and the business cycle: An introduction to the New Keynesian framework and its applications*, Princeton University Press, 2 ed.

——— (2020a): "The effects of a money-financed fiscal stimulus," *Journal of Monetary Economics*, 115, 1–19.

——— (2020b): "Helicopter money: The time is now," in *Europe in the Time of Covid-19*, CEPR Press London, UK, chap. 33, 230–235.

GERTLER, M. AND N. KIYOTAKI (2010): "Financial Intermediation and Credit Policy in Business Cycle Analysis," in *Handbook of Monetary Economics*, ed. by B. M. Friedman and M. Woodford, Elsevier, vol. 3, chap. 11, 547–599.

GOODHART, C., D. MASCIANDARO, AND S. UGOLINI (2021): "Pandemic recession, helicopter money and central banking: Venice, 1630," CEPR Discussion Paper No. 15715.

HARRISON, R. AND R. THOMAS (2019): "Monetary financing with interest-bearing money," Bank of England Working Paper No. 785.

OH, H. AND R. REIS (2012): "Targeted Transfers and the Fiscal Response to the Great Recession," *Journal of Monetary Economics*, 59, S50–S64.

REICHLIN, L., A. TURNER, AND M. WOODFORD (2019): "Helicopter money as a policy option," *VoxEU*.

REIS, R. (2013): "The Mystique Surrounding the Central Bank's Balance Sheet, Applied to the European Crisis," *American Economics Review Papers and Proceedings*, 103, 135–140.

——— (2019): "Can the Central Bank Alleviate Fiscal Burdens?" in *The Economics of Central Banking*, ed. by D. G. Mayes, P. L. Siklos, and J.-E. Sturm, Oxford University Press, Oxford University Press Handbooks in Economics.

ROGOFF, K. (2017): "Dealing with Monetary Paralysis at the Zero Bound," *Journal of Economic Perspectives*, 31, 47–66.

RYAN-COLLINS, J. AND F. VAN LERVEN (2018): "Bringing the helicopter to ground: A historical review of fiscal-monetary coordination to support economic growth in the 20th century," UCL Institute for Innovation and Public Purpose (IIPP) Working Paper No. 2018-08.

SIDRAUSKI, M. (1967a): "Inflation and economic growth," *Journal of Political Economy*, 75, 796–810.

——— (1967b): "Rational choice and patterns of growth in a monetary economy," *The American Economic Review*, 57, 534–544.

SINN, H.-W. (2017): "Helicopter money," in *Economic Ideas You Should Forget*, Springer, 129–130.

TURNER, A. (2015): "The case for monetary finance – An essentially political issue," in *16th Jacques Polak Annual Research Conference*, International Monetary Fund.

WOODFORD, M. (2003): *Interest and prices: Foundations of a theory of monetary policy*, Princeton University Press.

YASHIV, E. (2020): "Breaking the taboo: The political economy of COVID-motivated helicopter drops," in *Europe in the Time of Covid-19*, CEPR Press London, UK, chap. 35, 240–244.

Appendix – For Online Publication

This appendix lays out formally the optimal behavior conditions, and defines the equilibrium in what follows.

A Optimal behavior

The problem of the savers households is expressed by equations (3)-(6). Taking the sequence of output good prices, bond market prices, wages, capital income, and deposit interest $\{p_t, q_t, w_t, k_t, i_t^d\}_{t\geq 0}$ as given and believing that $\delta_t = 1$ at all t, the saver household solves:

$$\max_{c_t, l_t, h_{t+1}, d_{t+1}, b_{t+1}^p} \quad \sum_t \beta^t (\log(c_t) - \alpha l_t) \quad \text{subject to:} \tag{3}$$

$$p_t c_t (1 + \Psi_t) + q_t b_{t+1}^p + h_{t+1} + d_{t+1} = a_t + w_t l_t + k_t + s_t^p \tag{4}$$

$$a_t = \delta_t b_t^p + h_t + d_t (1 + i_t^d) \tag{5}$$

$$\Psi_t = \psi_h h^* \max\left\{\frac{p_t c_t}{h_t} - \frac{1}{h^*}, 0\right\} + \psi_d d^* \max\left\{\frac{p_t c_t}{d_t} - \frac{1}{d^*}, 0\right\} \tag{6}$$

Note that Ψ_t is a function of the endogenous choices c_t, h_t, d_t: $\Psi_t \equiv \Psi(c_t, h_t, d_t)$. To solve the problem, write it recursively:

$$\begin{aligned}
V(h_t, d_t, b_t^p) = \max_{c_t, l_t, h_{t+1}, d_{t+1}, b_{t+1}} & \log(c_t) - \alpha l_t + \beta V(h_{t+1}, d_{t+1}, b_{t+1}^p) \quad \text{subject to:} \\
& p_t c_t (1 + \Psi_t) + q_t b_{t+1}^p + h_{t+1} + d_{t+1} = a_t + w_t l_t + k_t + s_t^p \\
& a_t = \delta_t b_t^p + h_t + d_t (1 + i_t^d) \\
& \Psi_t = \psi_h h^* \max\left\{\frac{p_t c_t}{h_t} - \frac{1}{h^*}, 0\right\} + \psi_d d^* \max\left\{\frac{p_t c_t}{d_t} - \frac{1}{d^*}, 0\right\}
\end{aligned}$$

The Lagrangian is:

$$\begin{aligned}
\mathcal{L} = & \log(c_t) - \alpha l_t + \beta V(h_{t+1}, d_{t+1}, b_{t+1}^p) + \\
& \lambda_t \Big[\delta_t b_t^p + h_t + d_t (1 + i_t^d) + w_t l_t + k_t + s_t^p \\
& \quad - p_t c_t (1 + \Psi(c_t, h_t, d_t)) - q_t b_{t+1}^p - h_{t+1} - d_{t+1} \Big]
\end{aligned}$$

Necessary conditions for an optimum are:

$$\frac{\partial}{\partial c_t}\mathcal{L} = \frac{1}{c_t} + \lambda_t\Big[-p_t(1+\Psi_t) - p_t c_t \frac{\partial}{\partial c_t}\Psi_t\Big] = 0 \tag{A1}$$

$$\frac{\partial}{\partial l_t}\mathcal{L} = -\alpha + \lambda_t w_t = 0 \tag{A2}$$

$$\frac{\partial}{\partial h_{t+1}}\mathcal{L} = \beta\frac{\partial}{\partial h_{t+1}}V(h_{t+1}, d_{t+1}, b^p_{t+1}) - \lambda_t = 0 \tag{A3}$$

$$\frac{\partial}{\partial d_{t+1}}\mathcal{L} = \beta\frac{\partial}{\partial d_{t+1}}V(h_{t+1}, d_{t+1}, b^p_{t+1}) - \lambda_t = 0 \tag{A4}$$

$$\frac{\partial}{\partial b^b_{t+1}}\mathcal{L} = \beta\frac{\partial}{\partial b^p_{t+1}}V(h_{t+1}, d_{t+1}, b^p_{t+1}) - \lambda_t q_t = 0 \tag{A5}$$

$$\frac{\partial}{\partial h_t}V(h_t, d_t, b^p_t) = \frac{\partial}{\partial h_t}\mathcal{L} = \lambda_t\Big[1 - p_t c_t\frac{\partial}{\partial h_t}\Psi(c_t, h_t, d_t)\Big] \tag{A6}$$

$$\frac{\partial}{\partial d_t}V(h_t, d_t, b^p_t) = \frac{\partial}{\partial h_t}\mathcal{L} = \lambda_t\Big[(1+i^d_t) - p_t c_t\frac{\partial}{\partial d_t}\Psi(c_t, h_t, d_t)\Big] \tag{A7}$$

$$\frac{\partial}{\partial b^p_t}V(h_t, d_t, b^p_t) = \frac{\partial}{\partial b^p_t}\mathcal{L} = \lambda_t\delta_t \tag{A8}$$

Iterating the Envelope conditions (A6)-(A8) one period forward yields:

$$\frac{1}{c_t} = \lambda_t p_t\Big[1 + \Psi(c_t, h_t, d_t) + c_t\frac{\partial}{\partial c_t}\Psi(c_t, h_t, d_t)\Big] \tag{A9}$$

$$\Longrightarrow \lambda_t = \frac{1}{c_t p_t\Big[1 + \Psi(c_t, h_t, d_t) + c_t\frac{\partial}{\partial c_t}\Psi(c_t, h_t, d_t)\Big]} \tag{A10}$$

$$\alpha = \lambda_t w_t \tag{A11}$$

$$\lambda_t = \beta\lambda_{t+1}\Big[1 - p_{t+1}c_{t+1}\frac{\partial}{\partial h_{t+1}}\Psi(c_{t+1}, h_{t+1}, d_{t+1})\Big] \tag{A12}$$

$$\lambda_t = \beta\lambda_{t+1}\Big[(1+i^d_{t+1}) - p_{t+1}c_{t+1}\frac{\partial}{\partial d_{t+1}}\Psi(c_{t+1}, h_{t+1}, d_{t+1})\Big] \tag{A13}$$

$$\lambda_t q_t = \beta\lambda_{t+1}\delta_{t+1} \Longrightarrow \lambda_t = \beta\lambda_{t+1}(1+i_{t+1}) \tag{A14}$$

To derive the Euler equation, plug equation (A10) into (A14):

$$\frac{1}{c_t p_t\left[1+\Psi(c_t,h_t,d_t)+c_t\frac{\partial}{\partial c_t}\Psi_t\right]} = \beta\frac{1+i_t}{c_{t+1}p_{t+1}\left[1+\Psi_{t+1}+c_{t+1}\frac{\partial}{\partial c_{t+1}}\Psi_{t+1}\right]} \tag{A15}$$

$$\implies (1+i_t)\underbrace{\frac{p_t}{p_{t+1}}}_{=\frac{1}{\pi_{t+1}}} = \left(\frac{c_{t+1}}{\beta c_t}\right)\left(\frac{1+\Psi_{t+1}+c_{t+1}\frac{\partial}{\partial c_{t+1}}\Psi_{t+1}}{1+\Psi_t+c_t\frac{\partial}{\partial c_t}\Psi_t}\right) \tag{A16}$$

To obtain the flexible-price benchmark consumption for savers-households, combine the flexible pricing benchmark of non-financial firms, $p_t = \frac{\mu_t w_t}{A_t}$, with equations (A10) and (A11):

$$\begin{aligned}
p_t = \frac{\mu_t w_t}{A_t} &\implies w_t = \frac{A_t}{\mu_t}p_t \\
\alpha = \lambda_t w_t &= \frac{1}{c_t p_t\left[1+\Psi(c_t,h_t,d_t)+c_t\frac{\partial}{\partial c_t}\Psi(c_t,h_t,d_t)\right]}\frac{A_t}{\mu_t}p_t \\
\implies c_t &= \frac{A_t}{\alpha\mu_t\left[1+\Psi(c_t,h_t,d_t)+c_t\frac{\partial}{\partial c_t}\Psi(c_t,h_t,d_t)\right]}
\end{aligned}$$

To solve for the savers-household demand for cash, write equations (A12) and (A14) in terms of $\frac{\lambda_t}{\lambda_{t+1}}$ and equate:

$$\begin{aligned}
\beta(1+i_{t+1}) &= \beta\left[1-p_{t+1}c_{t+1}\frac{\partial}{\partial h_{t+1}}\Psi(c_{t+1},h_{t+1},d_{t+1})\right] \\
\implies i_{t+1} &= -p_{t+1}c_{t+1}\underbrace{\frac{\partial}{\partial h_{t+1}}\Psi(c_{t+1},h_{t+1},d_{t+1})}_{-\psi_h h^*\frac{p_{t+1}c_{t+1}}{h_{t+1}^2}\mathcal{I}\left\{\frac{p_{t+1}c_{t+1}}{h_{t+1}}-\frac{1}{h^*}>0\right\}} \\
&= \frac{p_{t+1}^2 c_{t+1}^2}{h_{t+1}^2}\psi_h h^*\mathcal{I}\left\{\frac{p_{t+1}c_{t+1}}{h_{t+1}}-\frac{1}{h^*}>0\right\} \\
\implies h_{t+1} &= p_{t+1}c_{t+1}\sqrt{\frac{\psi_h h^*}{i_{t+1}}}\mathcal{I}\left\{\frac{p_{t+1}c_{t+1}}{h_{t+1}}-\frac{1}{h^*}>0\right\}
\end{aligned}$$

The indicator can be rewritten using the demand just derived. If $\frac{p_{t+1}c_{t+1}}{h_{t+1}} - \frac{1}{h^*} > 0$, then

$$\frac{p_{t+1}c_{t+1}}{h_{t+1}} = \sqrt{\frac{i_{t+1}}{\psi_h h^*}} \quad \text{and}$$
$$\frac{p_{t+1}c_{t+1}}{h_{t+1}} - \frac{1}{h^*} > 0 \iff \frac{i_{t+1}}{\psi_h h^*} > \frac{1}{h^{*2}} \iff i_{t+1} > \frac{\psi_h}{h^*}$$

To solve for the savers-household demand for bank deposits, proceed analogously with (A13) and (A14):

$$\beta(1 + i_{t+1}) = \beta\Big[1 + i^d_{t+1} - p_{t+1}c_{t+1}\frac{\partial}{\partial d_{t+1}}\Psi(c_{t+1}, h_{t+1}, d_{t+1})\Big]$$
$$\implies i_{t+1} = i^d_{t+1} - p_{t+1}c_{t+1} \underbrace{\frac{\partial}{\partial d_{t+1}}\Psi(c_{t+1}, h_{t+1}, d_{t+1})}_{-\psi_d d^* \frac{p_{t+1}c_{t+1}}{d^2_{t+1}} \mathcal{I}\left\{\frac{p_{t+1}c_{t+1}}{d_{t+1}} - \frac{1}{d^*} > 0\right\}}$$
$$= \frac{p^2_{t+1}c^2_{t+1}}{d^2_{t+1}}\psi_d d^* \mathcal{I}\left\{\frac{p_{t+1}c_{t+1}}{d_{t+1}} - \frac{1}{d^*} > 0\right\}$$
$$\implies d_{t+1} = p_{t+1}c_{t+1}\sqrt{\frac{\psi_d d^*}{i_{t+1} - i^d_{t+1}}}\mathcal{I}\left\{i_{t+1} - i^d_{t+1} > \frac{\psi_d}{d^*}\right\}$$

The financial firms' problem is given by equation (8):

$$\max_{d_{t+1}, v_{t+1}, b^f_{t+1}} \; n_{t+1} = (1 + i^v_{t+1})v_{t+1} + \delta_{t+1}b^f_{t+1} - d_{t+1}(1 + i^d_{t+1}) + s^f_{t+1} \quad \text{subject to:}$$
$$\begin{cases} q_t b^f_{t+1} + v_{t+1} \le \bar{n} + d_{t+1} & \text{Equity (="Budget") Constraint} \\ (1 + i^d_{+1})d_{t+1} \le \gamma\left(n_{t+1} + (1 + i^d_{t+1})d_{t+1}\right) & \text{Leverage Constraint} \\ \theta d_{t+1} \le v_{t+1} & \text{Reserve Constraint} \end{cases}$$

If $i^v_{t+1} \ge i_{t+1}$, then the bank holds reserves and no bonds, and the reserve constraint does not bind. If $i^d_{t+1} \ge i^v_{t+1} = i_{t+1}$, the bank can not make profit and the leverage constraint does not bind. If only the reserve constraint binds, then $\theta d_{t+1} = v_{t+1}$ and $i^v < i^d < i$. If only the leverage constraint binds, then:

$$\begin{aligned}(1+i^d_{t+1})d_{t+1} &= \gamma\left(n_{t+1} + (1+i^d_{t+1})d_{t+1}\right)\\ &= \gamma\left((1+i^v_{t+1})v_{t+1} + \delta_{t+1}b^f_{t+1} + s^f_{t+1}\right)\end{aligned}$$

From the equity constraint we get:

$$q_t b^f_{t+1} + v_{t+1} = \bar{n} + d_{t+1} \Longrightarrow b^f_{t+1} = (1+i_{t+1})\left(\bar{n} + d_{t+1} - v_{t+1}\right)$$

Plugging the latter into the former yields:

$$\begin{aligned}&\left(1+i^d_{t+1} - \gamma(1+i_{t+1})\right)d_{t+1} = \gamma(1+i_{t+1})\bar{n} + \gamma(i^v_{t+1} - i_{t+1})v_{t+1} + \gamma s^f_{t+1}\\ &\Longrightarrow d_{t+1} = \left(\frac{1}{\frac{1+i^d_{t+1}}{\gamma} - (1+i_{t+1})}\right)\left((1+i_{t+1})\bar{n} + (i^v_{t+1} - i_{t+1})v_{t+1} + s^f_{t+1}\right)\end{aligned}$$

In particular with the no-arbitrage condition $i^v_{t+1} = i_{t+1}$:

$$d_{t+1} = \left(\frac{1}{\frac{1+i^d_{t+1}}{\gamma(1+i_{t+1})} - 1}\right)\left(\bar{n} + \frac{1}{(1+i_{t+1})}s^f_{t+1}\right) \tag{A17}$$

B Statement of equilibrium

An equilibrium of the economy is a sequence of prices $\{p_t, w_t, i_{t+1}, i^d_{t+1}, i^v_{t+1}\}_{t\geq 0}$ and quantities $\{y_t, c^h_t, c^p_t, g_t, l_t, h_{t+1}, d_{t+1}, b^p_{t+1}, b^f_{t+1}, b^c_{t+1}, b_{t+1}, v_{t+1}, s^h_t, s^p_t, s^f_t, s_t, k_t\}_{t\geq 0}$ such that:

- Spender households spend their allotted fiscal transfer on consumption goods every period, taking output good prices $\{p_t\}_{t\geq 0}$ as given:

$$c^h_t = \frac{s^h_t}{p_t}$$

- Saver households optimise their choices of consumption, labour supply, bond holdings, cash holdings, and bank deposit supply $\{c_t, l_t, h_{t+1}, d_{t+1}, b^p_{t+1}\}_{t\geq 0}$, taking as given the levels of output good prices, wages, bond returns, and deposit interests $\{p_t, w_t, i_{t+1}, i^d_{t+1}\}_{t\geq 0}$, such that the following equations hold (and $1+i_{t+1} = 1/q_t$:

$$\frac{(1+i_t)}{\pi_{t+1}} = \left(\frac{c_{t+1}}{\beta c_t}\right)\left(\frac{1+\Psi_{t+1}+c_{t+1}\frac{\partial}{\partial c_{t+1}}\Psi_{t+1}}{1+\Psi_t+c_t\frac{\partial}{\partial c_t}\Psi_t}\right) \tag{Euler Equation}$$

$$\alpha = \frac{w_t}{c_t p_t\left[1+\Psi(c_t,h_t,d_t)+c_t\frac{\partial}{\partial c_t}\Psi(c_t,h_t,d_t)\right]} \tag{Static Consumption-Leisure}$$

$$h_{t+1} = p_{t+1}c_{t+1}\sqrt{\frac{\psi_h h^*}{i_{t+1}}}\mathcal{I}\left\{i_{t+1} > \frac{\psi_h}{h^*}\right\} \tag{Cash Demand}$$

$$d_{t+1} = p_{t+1}c_{t+1}\sqrt{\frac{\psi_d d^*}{i_{t+1}-i^d_{t+1}}}\mathcal{I}\left\{i_{t+1}-i^d_{t+1} > \frac{\psi_d}{d^*}\right\} \tag{Deposit Demand}$$

$$p_t c_t(1+\Psi_t) + q_t b^p_{t+1} + h_{t+1} + d_{t+1} = \delta_t b^p_t + h_t + d_t(1+i^d_t) + w_t l_t + k_t + s^p_t \tag{Consumer Budget Constraint}$$

- Non-financial firms optimise their choice of labour demand $\{l_t\}_{t\geq 0}$, taking as given the levels of wages $\{w_t\}_{t\geq 0}$:

$$k_t = p_t y_t - w_t l_t \tag{Firm Profit}$$
$$y_t = A_t l_t \tag{Production Function}$$
$$w_t = p_t A_t \tag{Competitive Labour Market}$$

- Financial firms (banks) optimise their choices of bank deposit supply, central bank reserve holdings, and bond holdings $\{d_{t+1}, v_{t+1}, b^f_{t+1}\}_{t\geq 0}$, taking as given the levels of deposit interest rate, central bank reserves interest rate, and bond returns

$\{i^d_{t+1}, i^v_{t+1} = i_{t+1}\}_{t\geq 0}$:

$$d^f_{t+1} = \begin{cases} \left(\frac{1}{\frac{1+i^d_{t+1}}{\gamma(1+i_{t+1})}-1}\right)\left(\bar{n} + \frac{1}{(1+i_{t+1})}s^f_{t+1}\right) & \text{if } i^d_{t+1} \leq i^v_{t+1} = i_{t+1} \\ 0 & \text{otherwise} \end{cases}$$

- The central bank chooses its bond holdings, currency in circulation, and reserves offered $\{b^c_{t+1}, h_{t+1}, v_{t+1}\}_{t\geq 0}$, and sets interest rates $\{i_{t+1} = i^v_{t+1}\}_{t\geq 0}$ facing:

$$v_{t+1} - v_t + h_{t+1} - h_t + \delta_t b^c_t = q_t b^c_{t+1} + i^v_t v_t + x_t \qquad \text{(CB Budget Constraint)}$$

- The fiscal authority chooses bond supply, transfers, government purchases, and central bank recapitalisation $\{b_t, s_t, s^h_t, s^p_t, s^f_t, g_t, x_t\}_{t\geq 0}$, taking as given price level and bond returns $\{p_t, i_{t+1}\}_{t\geq 0}$:

$$x_t + q_t b_{t+1} = \delta b_t + s_t + p_t g_t \qquad \text{(Fiscal Authority Budget Constraint)}$$
$$s_t = s^h_t + s^p_t + s^f_t \qquad \text{(Transfers)}$$

- Markets clear:

$$b^p_{t+1} + b^f_{t+1} + b^c_{t+1} = b_{t+1} \qquad \text{(Bonds)}$$
$$c^h_t + (1+\Psi_t)c^p_t + g_t = y_t \qquad \text{(Output Good)}$$